SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING MARCH 1933

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments and their exposures, the reader is referred to the January 1932 REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged above normal for February at Washington and Madison, and close to normal at Lincoln.

Table 2 shows an excess in the total solar radiation received on a horizontal surface at all stations except Madison, Lincoln, Pittsburgh, and La Jolla.

Table 3 shows the effect of cirri on turbidity factors; particularly on the 27th.

Polarization measurements made on 5 days at Washington give a mean of 49 percent with a maximum of 54 percent on the 29th. These are slightly below normal for the month. No polarization readings were obtained at Madison due to the presence of ice and snow.

TABLE 1.—*Solar radiation intensities during March 1933*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D.C.

Date	Sun's zenith distance. 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass A.M.					P.M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
Mar. 6	2.62	0.87	1.08	1.22	1.29						1.45
Mar. 8	5.16	.83	1.05	1.14	1.32	1.58					4.57
Mar. 9	2.11						1.19				1.24
Mar. 17	3.81					1.29					4.75
Mar. 27	3.15	.47	.59	.77							2.74
Mar. 28	4.17				.88						3.99
Mar. 29	2.74	.80	.91	1.03	1.26	1.43	1.21				3.00
Means		.74	.91	1.04	1.19	1.43	(1.20)				
Departures		+.01	+.10	+0.09	+.04	±0.00	+0.07				

TABLE 1.—*Solar radiation intensities during March 1933*—Contd.

Madison, Wis.

Date	Sun's zenith distance. 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass A.M.					P.M.				Local mean solar
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
Mar. 1	1.68			1.26	1.44	1.67					2.36
Mar. 2	2.74						1.50				3.45
Mar. 10	.86		1.04	1.25	1.50	1.61	1.24				1.02
Mar. 15	1.68		1.08	1.20	1.38	1.61	1.41				1.60
Mar. 22	2.36		1.03	1.10	1.34	1.64	1.46				2.49
Mar. 24	2.49		.83	.97							3.45
Mar. 27	4.75				1.08						3.81
Means			1.00	1.16	1.35	1.63	1.40				
Departures			−.04	−.01	+.03	+.04	+.10				

Lincoln, Nebr.

Mar. 2	2.74				1.10		1.20	0.99	0.90	0.80	2.62
Mar. 3	2.74						1.25	1.05	.90	.74	3.30
Mar. 11	2.87	0.74	0.87	1.06	1.24	1.45					4.17
Mar. 13	8.81				1.16	1.38	1.22	1.02	.89	.77	6.76
Mar. 15	3.00	.87	1.00	1.16	1.33	1.52					3.63
Mar. 16	3.63					1.28	1.13	.99	.80	.67	3.63
Mar. 21	1.60	.96	1.08	1.22	1.42	1.57	1.37	1.21	1.08	.99	2.36
Mar. 23	3.63			1.10	1.29						3.45
Mar. 27	4.57						1.30	1.10	.93	.87	4.37
Mar. 31	5.56						1.27	1.09	.96	.85	5.56
Means		.86	.98	1.14	1.26	1.44	1.25	1.06	.92	.80	
Departures		+.02	+.04	+.05	−.01	−.08	−.03	−.03	−.02	−.01	

Blue Hill, Mass.

Mar. 5	2.2				1.37	1.50					2.2
Mar. 6	1.5				1.30	1.62	1.31				1.8
Mar. 9	2.6						1.22	0.89			2.7
Mar. 10	1.6				1.28						1.5
Mar. 11	1.2			1.21	1.38	1.56	1.36				1.5
Mar. 12	2.0			.85	.92						2.2
Mar. 16	2.2			1.15	1.35	1.58	1.36	1.17			2.3
Mar. 24	3.1				1.13		1.18				3.1
Mar. 25	3.4				1.17	1.52					3.3
Mar. 27	3.8					1.44	1.19	.98			3.4
Mar. 30	2.3				1.30	1.51	1.30				2.2
Means				1.07	1.24	1.53	1.27	1.01			

[1] Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Gainesville	Miami	New Orleans
	Gram calories per square centimeter												
1933	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Feb. 26	335	254	348	229	248	454	184	172	343	243	381	410	272
Mar. 5	582	272	335	249	319	381	237	158	352	299	443	392	288
Mar. 12	292	271	370	217	268	402	210	207	348	362	444	475	237
Mar. 19	150	275	355	159	211	537	107	205	401	365	385	443	372
Mar. 26	378	248	410	253	297	500	265	241	403	361	500	480	328
	Departures from weekly normals												
Feb. 26	+45	−27	+9	+29	+12	+70	−2		+43	−90	−30	+26	
Mar. 5	+252	−28	−18	+45	+54	±0	+33		+39	−39	+45	−15	
Mar. 12	−35	−46	−5	+9	−5	+2	−7		+19	+13	+45	+39	
Mar. 19	−198	−42	−39	−59	−58	+79	−119		+53	−9	±0	−15	
Mar. 26	+30	−100	+2	+9	+17	+2	+14		+17	−42	−4	+4	
	Accumulated departures on Apr. 2, 1933												
	+2,394	−2,191	−924	+2,562	+2,282	+2,191	+553		+1,099	−1,568	−5,131	−567	

TABLE 3.—*Solar-radiation measurements, and determinations of atmospheric turbidity factor, β, Washington, D.C., March 1933*

Date and solar hour angle	Solar altitude, h	Air mass, m	I_m cal.	I_y cal.	I_r cal.	β	Blueness of sky	Atmospheric dust particles per cubic centimeter	Notes: Skylight polarization, P, clouds, etc.
1933									
Mar. 6									
3:54 a	20-01	2.90	1.225	0.877	*0.758*	0.040		914	
3:48 a	21-03	2.77	1.244	*.828*	.744	.040			
3:44 a	21-45	2.69	1.269	.934	.756	.038			
3:40 a	22-26	2.61	1.280	.936	.759	.035			
2:46 a	31-16	1.92	1.285	.880	.735	.060	5		P=51.2%
2:42 a	31-20	1.92	1.257	.880	*.755*	.070			Cirri.
Mar. 9									
4:18 a	16-34	3.48	1.079	.791	*.665*	.042		275	
4:12 a	17-34	3.28	1.105	*.797*	.667	.040			
3:35 a	24-10	2.43	1.217	*.881*	.707	.045			
3:29 a	25-10	2.34	1.250	.879	*.712*	.040			
2:40 a	32-54	1.84	1.340	.918	*.746*	.045	5		P=48.2%
2:37 a	33-29	1.81	1.360	*.921*	.747	.045			
1:27 a	42-08	1.49	1.444	*.921*	.735	.040			
1:20 a	42-47	1.47	1.463	.922	*.755*	.035			
Mar. 27									
4:51 a	15-00	3.82	.645	*.488*	.447	.130		899	
4:48 a	15-36	3.68	.644	.491	*.450*	.135			
4:27 a	19-40	2.95	.753	.569	*.516*	.165			Cirri.
4:22 a	20-35	2.82	.787	*.571*	.521	.165			
3:51 a	26-34	2.23	.816	*.635*	.537	.180			
3:47 a	27-18	2.17	.832	.638	*.540*	.180	4		P=42.6%
Mar. 29									
4:57 a	14-24	3.98	.909	.688	*.591*	.065		317	
4:54 a	14-58	3.84	.922	*.691*	.596	.065			
4:33 a	19-02	3.05	1.029	*.765*	.647	.075			
4:28 a	19-56	2.92	1.058	.769	*.650*	.065			
4:20 a	21-36	2.70	1.075	.794	*.671*	.078			
4:16 a	22-12	2.63	1.106	*.797*	.672	.072			
3:51 a	26-51	2.21	1.211	*.853*	.700	.060			
3:47 a	27-35	2.15	1.236	.856	*.700*	.052	6		P=53.7%
2:13 a	43-22	1.46	1.353	.888	*.700*	.105			
2:09 a	43-56	1.44	1.338	*.891*	.700	.115			
0:55 a	52-20	1.27	1.424	*.935*	.759	.068			
0:51 a	52-40	1.26	1.429	.938	.759	.068			
1:36 p	48-19	1.34	1.350	.950	*.774*	.110			
1:42 p	47-36	1.36	1.306	*.953*	.771	.140			
2:43 p	38-42	1.60	1.295	*.884*	.694	.140			
2:47 p	37-40	1.63	1.301	.887	*.694*	.140			
3:26 p	31-14	1.93	1.218	.860	*.694*	.135			
3:30 p	30-42	1.95	1.221	*.865*	.697	.135			

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, Superintendent United States Naval Observatory. Data furnished by Naval Observatory, in cooperation with Harvard, Perkins, and Mount Wilson Observatories. The differences of latitude are measured from central meridian, positive west. The north latitude are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1933	h. m.	°	°	°			
Mar. 1 (Naval Observatory)	11 56	−64.0	305.4	+13.0	------	123	123
Mar. 2 (Mount Wilson)	12 0	−51.0	305.2	+14.0	------	223	------
		−23.0	333.2	+9.0	11	------	234
Mar. 3 (Naval Observatory)	11 34	−37.0	306.3	+13.0	------	93	93
Mar. 4 (Naval Observatory)	11 35	−24.0	306.1	+13.0	------	93	93
Mar. 5 (Perkins Observatory)	16 0	−13.5	301.0	+13.0	------	90	------
		−4.5	310.0	+16.5	------	90	180
Mar. 6 (Naval Observatory)	11 0	+3.0	307.0	+13.0	------	93	93
Mar. 7 (Mount Wilson)	12 35	+16.0	306.0	+14.0	------	118	118

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
	h. m.	°	°	°			
Mar. 8 (Naval Observatory)	11 51	+24.0	301.2	+11.0	------	9	------
		+33.0	310.2	+15.0	77	------	86
Mar. 9 (Naval Observatory)	10 5	+37.0	302.0	+11.0	------	9	------
		+46.0	311.0	+15.0	77	------	86
Mar. 10 (Naval Observatory)	11 8	+60.0	311.3	+15.0	77	------	77
Mar. 11 (Naval Observatory)	11 49	+74.0	311.7	+15.0	77	------	77
Mar. 12 (Perkins Observatory)	14 0	No spots			------	------	------
Mar. 13 (Mount Wilson)	11 30	No spots			------	------	------
Mar. 14 (Mount Wilson)	12 25	No spots			------	------	------
Mar. 15 (Naval Observatory)	10 58	No spots			------	------	------
Mar. 16 (Naval Observatory)	11 35	No spots			------	------	------
Mar. 17 (Naval Observatory)	11 44	No spots			------	------	------
Mar. 18 (Mount Wilson)	11 0	No spots			------	------	------
Mar. 19 (Mount Wilson)	10 50	No spots			------	------	------
Mar. 20 (Mount Wilson)	10 45	No spots			------	------	------
Mar. 21 (Mount Wilson)	11 0	No spots			------	------	------
Mar. 22 (Naval Observatory)	13 28	−73.0	18.8	+4.0	------	401	401
Mar. 23 (Mount Wilson)	11 45	−58.0	21.5	+5.0	------	408	408
Mar. 24 (Naval Observatory)	13 44	−45.0	20.3	+4.0	------	216	216
Mar. 25 (Mount Wilson)	11 30	−32.0	21.3	+5.0	------	234	------
		+20.0	73.3	+10.0	------	31	265
Mar. 26 (Naval Observatory)	12 44	−18.0	21.5	+4.0	------	247	------
		+35.0	74.5	+10.0	------	77	324
Mar. 27 (Mount Wilson)	11 15	−5.0	22.1	+5.0	------	200	------
		+49.0	76.1	+10.0	------	44	244
Mar. 28 (Naval Observatory)	11 20	+8.0	21.9	+5.0	------	185	------
		+62.0	75.9	+10.0	------	93	278
Mar. 29 (Naval Observatory)	10 54	+22.0	22.9	+5.0	------	170	170
Mar. 30 (Naval Observatory)	11 13	+36.0	23.5	+5.0	------	123	123
Mar. 31 (Mount Wilson)	11 10	+49.0	23.3	+4.0	------	131	131
Mean daily area for March							123

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PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR MARCH 1933

[Dependent alone on observations at Zurich and its station at Arosa]

[Data furnished through the courtesy of Prof. W. Brunner, University of Zurich, Switzerland]

March 1933	Relative numbers	March 1933	Relative numbers	March 1933	Relative numbers
1	10	11	7	21	0
2	10	12	7	22	*d*12
3	10	13	0	23	14
4	13	14	0	24	14
5	11	15	0	25	*Mc*24
6	*a*11	16	0	26	29
7	11	17	0	27	26
8	------	18	0	28	*a*28
9	9	19	0	29	22
10	8	20	0	30	*d*12
				31	10

Mean: 30 days=10.0.

a=Passage of an average-sized group through the central meridian.
b=Passage of a large group or spot through the central meridian.
c=New formation of a center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central zone.
d=Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, W. R. Gregg, in charge]

By L. T. SAMUELS

Free-air temperatures during March were above normal at all stations except Chicago and Cleveland. (See table 1.) The departures were only of moderate magnitude. Free-air relative humidities averaged above normal with departures of small to moderate magnitude in most cases.

There were no important deviations in the monthly resultant winds as compared to the normals.